8. DEVELOPMENT OF ALTERNATIVES

Remedial alternatives for sites cleanup are developed in this section. Representative technologies selected in Section 7.6 are combined to formulate a range of response actions appropriate for OU 9-04 contaminant types and site conditions. Tables 8-1 and 8-2 show the alternatives developed for OU 9-04 site groupings including radiologically contaminated soils and sites with inorganics contributing to ecological risks, respectively.

8.1 Alternative 1, No Action

Formulation of a No Action alternative is required by the National Contingency Plan (NCP) [40 CFR 300.430 (e)(6)] and guidance for conducting feasibility studies under CERCLA (EPA 1988). The No Action alternative serves as the baseline for evaluating other remedial action alternatives. This alternative can include environmental monitoring, but does not include actions to reduce potential exposure pathways, such as fencing or deed restrictions (EPA 1988). Therefore, the No Action alternative developed for OU 9-04 drainage ditches and pond involves only environmental monitoring (groundwater, air, and sediment) for at least 100 years after site closure.

8.2 Alternative 2, Limited Action

A limited-action alternative was developed that involves only institutional controls to remain in effect for a minimum of 100 years. This alternative essentially continues management practices currently in place at OU 9-04. Actions under this alternative focus on routine maintenance and upkeep of the drainage ditches and disposal pond, restricting access (fences and deed restrictions), and environmental monitoring including radiation surveys.

Cap integrity monitoring and radiation survey programs would be established to ensure the functionality of existing surface soil covers where they exist, and would provide early detection of potential contaminant migration. These programs would be implemented annually for the first 5 years following site closure. The need for further environmental monitoring would be evaluated and determined by the Agencies during subsequent 5-year reviews (see Section 7.5.2).

8.3 Alternatives 3a and 3b Containment

The alternatives developed for containment of contaminants at OU 9-04 are based on capping technologies designed to satisfy the RAOs described in Section 7.1 by eliminating exposure pathways identified in the baseline risk assessment (BRA). The containment alternatives would meet the RAOs for the radiologically contaminated soils and sites contributing to ecological concerns. Human health risks due to radionuclides decline to acceptable levels within 130 years for Cs-137, and over 1,000 years for Ra-226. Ecological risks are predominantly caused by inorganics, which are assumed to remain indefinitely. Containment technologies must be designed to maintain integrity for the period of time that unacceptable cumulative exposure risks will be present. The functional life of a particular cap design is based on erosion prevention, minimization of subsidence and settlement, prevention of slope failure, resistance to infiltration, resistance to biotic and human intrusion, and the materials used for construction.

Table 8-1. Remedial alternatives for sites with radiological contaminants.

	Remedial Alternatives				
Process options	No Action	Limited Action	Containment engineered barrier	Excavate and disposal in landfill	Phytoremediation
Soil monitoring	X	X	X	X	X
Air monitoring	X	X	X	X	X
Groundwater monitoring	X	X	X	X	X
Fences		X	X	X	X
Deed restrictions		X	X	X	X
Cap integrity monitoring and maintenance		X	X	X	X
Surface water diversions		X	X	X	X
Backhoes, dozers, farm implements				X	X
Engineered barrier			X		
Low-level radioactive soil landfill				X	X

X = Process option included

Table 8-2. Remedial alternatives for sites contributing to ecological risks.

	Remedial Alternatives					
Process options	No Action	Limited Action	Containment engineered barrier	Containment native soil cover	Excavate and disposal in landfill	Phytoremediation
Soil monitoring	X	X	X	X	X	X
Air monitoring	X	X	X	X	X	X
Groundwater monitoring	X	X	X	X	X	X
Fences		X	X	X	X	X
Deed restrictions		X	X	X	X	X
Cap integrity monitoring and maintenance		X	X	X	X	
Surface water diversions		X	X	X	X	X
Backhoes, dozers, and farm implements					X	X
Engineered barrier			X			
Native soil cover				X		

X = Process option included

The OU 5-05/6-01 FS identified four basic capping designs for development of containment alternatives applicable to the SL-1 and BORAX-I burial grounds. Based on the results of the OU 5-05/6-01 analysis of alternatives, this focused FS for OU 9-04 sites uses a shorter list of containment alternatives as a starting point. The following three types of closure covers were identified as most likely to be applicable to OU 9-04 sites of concern:

- Multi-layer engineered cover: designed for stabilization of abandoned uranium mill tailings, consisting of geologic materials.

- Soil-only cover: consisting of a thick layer of native soil with surface vegetation, rock armor, or other surface cover.

The engineered barrier containment alternative developed for OU 9-04, radiologically contaminated soils utilizes the barrier designed for the SL-1 burial ground and consists of geologic materials including native soil, gravel, basalt cobbles, and rip-rap. Variations from this conceptual design are possible based on layer thickness, layer materials, layer order, location of the biobarrier in the cap profile and other considerations. The preconceptual designs identified for containment alternatives in this FS would be developed during remedial design and modified as needed to meet defined functional and operational requirements, with the concurrence of regulatory agencies.

To complete the remedial action alternatives developed for containment (Sections 8.3.1, 8.3.2, and 8.3.3), the caps identified above are combined with environmental monitoring and institutional controls that would remain in effect for at least 100 years after site closure. Monitoring and institutional controls considered appropriate to OU 9-04 sites include radiation surveys, cap integrity monitoring and maintenance (repairing any observable degradation including cracks, erosion, biotic intrusion, etc.), and developing and maintaining surface water diversions and access restrictions (fences and deed restrictions). Air monitoring and groundwater monitoring would be performed under current ANL-W programs. Operations and maintenance goals will be defined during remedial design. As discussed in Section 7.5.2, institutional controls are assumed to commence in 1998 and remain effective for at least 100 years, for cost estimating purposes.

Cap integrity monitoring and radiation survey programs would be implemented annually for the first 5 years following completion of the cap. The need for further environmental monitoring would be evaluated and determined by the Agencies during subsequent 5-year reviews.

Each containment alternative would also include surface water diversion controls to direct runoff away from the site. Throughout the remainder of this report, the terms cap, cover, and barrier will be used synonymously.

8.3.1 Alternative 3a, Containment Engineered Cover

The engineered cover utilizes the barrier designed for the SL-1 burial ground and consists of geologic materials including native soil, gravel, basalt cobbles, and rip-rap. Implementing this alternative (3a) for sites at ANL-W would entail consolidation of the both the radiological and ecological sites into one centralized location prior to capping. The volume of soils in most of the ANL-W sites is relatively small an the costs associated with building multiple engineered covers at each release site is not justifiable. The most logical centralized location for the engineered cover would be near the Interceptor Canal and the Industrial Waste Pond which have the largest volume of contaminated soil. The engineered cover (3a) would prevent both human and ecological receptors from contacting the soils. Additionally the engineered cover (3a) would be sloped accordingly to prevent ponding of surface waters which have the potential to leach the radiological and inorganic contaminants. Site-specific considerations (such as annual precipitation, frost depth, and anticipated soil erosion rates) will be used to design the optimum configuration for application at these OU 9-04 sites during the remedial design phase.

8.3.2 Alternative 3b, Containment Native Soil Cover

The native soil cover would consist of 10 ft of clean INEEL soil, with a surface covering of vegetation, rock armor or other material. Implementing this alternative at OU 9-04 would require a centralized location near these sites in which to build the containment, moving the contaminated soil to the centralized location, and then adding soil layers above grade to bring the total thickness to 10 ft. The native soil cover is applicable to both the radiologically and inorganically contaminated sites. But, the Ra-226 contamination has long half-life the long term effectiveness of this alternative to prevent external radiation exposure is questionable. The sites that only have Cs-137 as the radiological contamination (ANL-09-Mound and ANL-09-Canal) this alternative would be effective since the Cs-137 is at the upper limit of the NCP within 130 years.

8.4 Alternative 4a and 4b, Removal and Disposal

Removal and disposal alternatives for OU 9-04 sites can be accomplished by using standard construction equipment to excavate contaminated soils and sediments, and disposing of the contaminated material by landfilling. Details of how this alternative would be implemented for the types of contaminated sites present at OU 9-04 are discussed below.

8.4.1 Alternative 4a, Removal and Disposal at an INEEL Soil Repository

Implementing this alternative would require excavating all soils and debris from the radiological and inorganic contaminated sites that are above preliminary remediation goals (PRGs), and transporting the soil to the INEEL Soil Repository. The INEEL Soil Repository is currently undergoing public comment and if this repository is developed, it would open in for receipt of soils in the summer of 1999. The excavation and transport of the radiologically contaminated soils would require additional monitoring to verify no excess exposures are encountered. Verification sampling would be used to ensure that all contamination exceeding PRGs was removed.

8.4.2 Alternative 4b, Removal and Disposal at a Private Off-site Repository

Implementing this alternative would require excavating all soils and debris from the radiological and inorganically contaminated soils that are above the PRG's, and transporting the soil to a rail transfer station at CFA for shipment to a private disposal facility. The excavation and transport of the inorganically contaminated soils would require no additional monitoring because they do not have risks that are unacceptable to humans. The excavation and transport of the radiologically contaminated soils would require additional monitoring to ensure that no excess exposures are encountered. Verification sampling would be performed to ensure all contamination above the PRGs has been removed.

8.5 Alternative 5, Phytoremediation

This alternative would be implemented for both the radiological and inorganic contaminated sites at ANL-W. This alternative would consist of leaving most of the contaminated sites in their existing locations thus avoiding the high excavation and transport costs. One site the ANL-09-Mound has radiological contamination to a maximum depth of four feet, and the soils would be spread to the west to a maximum depth of 0.5 feet. A bench-scale tests would be conducted to determine which plants have the greatest potential to remove targeted radionuclides and inorganics. The bench-scale testing would be conducted during the winter of 1997-98 so the first plants could be planted in the spring of 1998. Both the radiological and inorganically contaminated soils are contained within the upper layer of the soil (0-0.5 ft.). The selected plants would be harvested prior to going to seed, dried, baled, and sent to the INEEL incinerator for disposal. Depending on the plants that are selected, two or more "crops" are possible each year. If this alternative is selected, ANL-W would perform two field seasons (1998 and 1999) and collect data to determine if the process is working and the remaining field seasons that would be required to meet the PRGs. This data would be required to determine the feasibility of the technology for the treatment of the radiological and inorganic contaminants at WAG 9. In 1999, after analysis of the soil samples, ANL-W along with the EPA and IDHW WAG 9 managers will determine if phytoremediation is working. If phytoremediation is not working or that the process is working slower than anticipated, a contingent alternative would be selected. If phytoremediation is working and the process continued, verification sampling would be used to ensure that no contamination exceeding PRGs remain.

8.6 References

EPA, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004, Interim Final, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, October 1988.

Lockheed Martin Idaho Technologies (LMIT), 1995, *Remedial Investigation/Feasibility Study Report for Operable Units 5-05 and 6-01 (SL-1 and BORAX-1 Burial Grounds)*, INEL-95/0027, Rev. 0, March.